Course guide
2301115 - 3DLICO - 3D Light Control for Biological Applications

Last modified: 16/06/2023

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: MASTER'S DEGREE IN PHOTONICS (Syllabus 2013). (Optional subject).

Academic year: 2023 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura

Others: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

TEACHING METHODOLOGY

Lectures
Hands-on training session on light control
Description:
- A practical session showing an encoded optical microscope and a varifocal lens will be held, with an estimated duration of 2 hours.
- Seminars based on the contents of the course may be included in the subject, depending on availability of relevant speakers.
Full-or-part-time: 2h

LEARNING OBJECTIVES OF THE SUBJECT

The ability to rapidly deliver light at targeted positions within a sample is the primary enabler of a number of biological applications ranging from imaging to laser surgery. However, optical diffraction and the non-homogeneities of biological tissue make it a challenging task. This can be further aggravated when the sample is moving or evolving, as in most in vivo systems. In this course, we will survey efforts to address these issues and achieve rapid three-dimensional control of light inside biological samples at cellular resolution. We will first describe the traditional and state-of-the-art methods, including optomechanical systems, varifocal lenses and beam shaping strategies. We will then provide examples of applications where they have been successfully used, both for imaging as well as non-imaging scenarios, such as optogenetics, deep light imaging and ultrafast microscopy.

STUDY LOAD

Type	Hours	Percentage
Hours large group	24,0	32.00
Self study	51,0	68.00

Total learning time: 75 h

CONTENTS

1. Methods for light-control in biological applications

Description:
Description:
1.1. The need for controlling light inside biological samples
1.2. Mechanical translation (piezoelectric, galvo mirror, resonant mirror)
1.3. Varifocal lenses
1.4. Remote focusing
1.5. Temporal focusing
1.6. Beam shaping (extended depth of field, non-conventional beam shapes)
1.7. Light modulation (phase and amplitude)
1.8. Computational methods
Full-or-part-time: 10h
Theory classes: 10h

Full-or-part-time: 10h
Theory classes: 10h

2. Applications in bioimaging

Description:
Description:
2.1. Endoscopy
2.2. Wavefront shaping
2.3. Photoacoustic microscopy
2.4. Encoded optical microscopy
Full-or-part-time: 8h
Theory classes: 8h

Full-or-part-time: 8h
Theory classes: 8h

3. Non-imaging scenarios

Description:
Description:
3.1. Optogenetics
3.2. Laser surgery
3.3. Photodynamic therapies
Full-or-part-time: 6h
Theory classes: 6h

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Theory classes: 6h

GRADING SYSTEM

- Written exam (30%)
- Oral presentation on a topic selected from a list provided by the professor (40%)
- Homework assignments, active attendance to classes, seminars and visit (30%)

BIBLIOGRAPHY

Basic:
- Chunlei Guo, Subhash Chandra Singh. Handbook of Laser Technology and Applications : Laser Applications: Medical, Metrology and Communication. (Volume Four). Boca Raton (FL), United States of America: CRC Press, 2021.
- James Powel. Handbook of Biological Confocal Microscopy. New York, United States of America: Springer, 2006.
- Kubby, Joel ; Gigan, Sylvain ; Cui, Meng. Wavefront Shaping for Biomedical Imaging. Cambridge, United Kingdom: Cambridge University Press, 2019. ISBN 9781316403938.